DOCUMENT RESUME

ED 133 092 RC 000 899

AUTHOR Gibbs, Doris
TITLE A Plan for Individualizing Instruction in Seventh Grade Mathematics Through the Use of Multi-Level Textbooks. Colorado Western States Small Schools Project Documentation (Ridgway High School, Ridgway, Colorado, 1963-64).
INSTITUTION Colorado Western States Small Schools Project, Denver.
PUB DATE 64
NOTE 22p.

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS Academic Achievement; Aptitude; Comparative Analysis; Educational Alternatives; *Grade 7; *Individualized Instruction; *Modern Mathematics; Post Testing; Pretesting; *Rural Areas; *Small Schools
IDENTIFIERS *Colorado (Ridgway); *Western States Small Schools Project

ABSTRACT

Seventh grade students (N=9) from a small rural school in Ridgway, Colorado were exposed to a teacher-developed individualized program in modern math during the 1962-63 school year and again the following year. The students were divided into an average and above group and a below average group; group assignments were determined by IQ scores, the California Arithmetic Test for Junior High (grade placement and percentile standing), and consultations with the student's former math teacher. Classroom procedures involved: use of two texts (one for each group); a self-paced format wherein students had access to problem answers and were required to test themselves only when they felt ready (a score of 80 or above was generally required for all but the poorest students); and no assigned homework. Each student was evaluated by September and May comparisons of SCAT, STEP, arithmetic, aptitude, and grade placement scores. Results indicated: the poorest student made an improvement of nearly one whole grade placement; the poorest improvement was .4% of a grade placement (slightly higher than average); and the two best students improved 2.4 and 3.4 grade placements. Changes affected during the 1963-64 school year involved: student goal setting; required homework (20 minutes); special projects; and different forms of the California test (results indicated gains, though not as large as those of the previous year). (JC)

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COLORADO WESTERN STATES SMALL SCHOOLS PROJECT

DOCUMENTATION

A PLAN FOR INDIVIDUALIZING INSTRUCTION IN SEVENTH GRADE MATHEMATICS THROUGH THE USE OF MULTI-LEVEL TEXTBOOKS

Mrs. Doris Gibbs
Ridgway High School
Ridgway, Colorado
1963 - 64

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For additional information concerning the Colorado WSSSP, contact:

Paul M. Nachtigal, Director
Colorado Western States Small Schools Project
State Department of Education
Denver, Colorado 80203

A PLAN FOR INDIVIDUALIZING INSTRUCTION IN SEVENTH GRADE MATHEMATICS THROUGH THE USE OF MULTI-LEVEL TEXTBOOKS

I. OVERVIEW

Ridgway School is a small school of approximately 60 students in grades 7 through 12. It is located in a farming and ranching district just 10 miles from Ouray, Colorado, which is a mining community. The town of Ridgway has a population of approximately 254 people. Half of the students are transported.

On an average there are about 10 pupils to a class. This is an ideal situation for the teacher to work individually with each one. This is the reason I wanted to try different work for each student, hoping that once the pressure of the group was off, much more and better work would be done.

I felt that the above average student in mathematics was not taxed in mathematical thinking. Realizing that most math students need work in addition, subtraction, multiplication, division, etc., I felt that others were losing precious time. This time could better be spent in the "why" of the process as the fundamentals were reviewed.

This project is not one that can be completed at the end of one year. To be sure, it is possible to gauge to some extent the result so far as needs, interest, enthusiasm, determination, and progress are concerned. However, my plan is to see whether better mathematics and science people are developed during the entire high school program.

I feel that the "Modern Math" will help the above average student have a feeling for abstractness so that he will be ready and able to go on into advanced math studies. His college math courses should, therefore, be easier for him and more quickly completed. I feel that this modern course will have a definite carry-over in the field of science. They will be ready to study science instead of having to also grasp scientific terms.

As I went back to school to study this "New Math", I was amazed at the many new things junior high and high school students were expected to squeeze into their math learning. As we discussed problems in our seminar, it seemed to be the consensus of opinion that the average (perhaps) and the above average students are the only ones capable and interested in the "why" of our numbers and number system. Certainly abstractness cannot be grasped by any but the better students. After thinking about these things, I decided to see whether the new math would be more stimulating than a regular course. I also thought it could be a big help in higher math courses as well as the science field.

II. PROCEDURE

As is true in every school, most students will only do what is required of them. Even outstanding students have to be highly motivated to want to do more than the average person. Of course in the fall, review of fundamental arithmetic principles is necessary. I did not realize how necessary it is for even the better students until I gave the California Arithmetic Test in the fall (see Table 2). However, there are different ways of re-teaching fundamentals. There is the old drill method which seems to be the best for your slower students. There is the method of solving written problems whose solving makes one very conscious of the fundamental principles. There is the method of learning new principles while you are re-establishing old fundamental principles.

I felt that the above average students would have no trouble going on with new things while re-learning old ones. They didn't. As you can see by the percentile standing in fundamentals in May (see Table 3) both top students ended up with fundamentals mastered. They were not afraid to work on their own and with a little help now and then could go twice as fast as the third top student.

So far as outstanding I.Q.'s (see Table 1), there are none. The average for the class is approximately 105, which is a good average class.

This class as a whole was used to having all kinds of teacher help. It was impossible to put the group all on their own immediately in the fall. I found it necessary to proceed as they were used to--daily assignment and daily recitation. However, I did have the below average students together in one group alone and the average and above average students in another group. This was to be a beginning for having one group independent of me while I was helping the other group.

At first this was very discouraging. The slower group could hardly get one problem done by next day unless I was there helping them think. I wondered how I could ever get them even partially independent. Perhaps my trouble came from the fact that this was the first time they just had to get it. Always before in their classes the brighter ones were there to help out if they were needed. The teacher could eventually get the right answer from the brighter ones or the slow student could get help with his homework (even if it did become just a copying act). Now here, they were having to get it by themselves or by helping each other.

For a while it appeared that I was wasting everybody's time. What a wonderful feeling it was when the first of the slow group "caught on". From then on, he could work alone and seemingly had a much better idea of what math was all about.

I did not use programed materials at all, but my process was very similar. The answer keys were available to any student at any time. If a pupil felt that perhaps he did not know what he was doing, he would check the answer after working only one problem. If he knew his process was right, he would usually wait until the end of the set of problems before checking his paper. Any problem missed was to be worked until the right answer was obtained. If the right answer wasn't forthcoming, he was not sure whether there was a mistake in the key or whether his work was wrong. Here is where the teacher came in. Together we would go through the thinking process. If his way of working the problem seemed to be right, then we would check fundamental arithmetic processes. If his mistake was

in addition, subtraction, multiplication, or division, he was very much chagrined to think that he went over and over the problem and could not find such a simple mistake.

At the end of certain phases of work, there was a test to be taken. I did not rush individuals into taking the test. I would emphasize that they had to know each principle in the work they had covered before trying the test. When they were ready for the test, they told me. If a certain score, usually 80 for the average student, was not received on the test, I felt that the material needed to be covered. There were principles that the student had not grasped or he would have received a better grade on the test.

This is where I feel my program needs to be improved. I need to spend more time getting together certain phases of remedial work. I would pick special problems from special pages that seemed to be the material the students needed to go over again. But here is where my students began to be bored. They were used to forging ahead, regardless. So long as they were covering new material all seemed well, but a "retake" was the end of their enthusiasm. I plan another year to use workbook sections, special remedial booklets which the California Testing Bureau makes for remedial work to help develop reasoning power and fundamental powers, other texts from which I can gather my own programed material.

My poorer students were not expected to get a score of 80 on their tests although some of them did. I was very happy to find that they could pass the tests. When working with groups in the classroom, you very seldom go slow enough for the slow learner to get enough to pass any text. The only trouble is that when you leave them on their own, they don't get through very much material during the course of the year. But in my own mind, I am sure that what they do get will stay with them better for having learned it more thoroughly while they were at it.

Just because the students use the answer keys to correct their own work until their solution is perfect does not mean that the teacher has been able to do away entirely with daily paper grading. I found that some of the students would try harder to make the teacher think they had corrected all problems than they would try to actually work out the process until the solution was right. Some would put a solution on their paper and at the bottom would be the right answer but the solution, if followed through, would not yield that answer.

By the end of the year most individuals were trying hard to be sure every problem was corrected, but some never quite realized that "honesty is the best policy".

I also had trouble, as I had anticipated, with the amount of work done. My two outstanding students gave no problem here. They were interested in what they were doing and were interested in learning all they could. However, they are slow workers so I know that many other students could have been much farther along than they were when school was out.

Somehow, I need to find a way to keep the average students going. I required no homework although we have only 50-minute periods in most of our classes. When I say required no homework, I mean to say that I talked favorably for it and certainly tried to encourage it but did not make it a requisite of the course. Again, I had no trouble encouraging the better students but the rest of the class were inclined to be lazy. The top two individuals were enthused about the challenge material given to them. I believe it was the first time in their school life that they had found that math made them think and dig. But the rest worked hard during class but that was usually the end of their math thoughts until the next day. The problem of "how to motivate" is still plaguing me.

Perhaps you have been wondering how I decided where to place each individual. In the first place, as I told you previously, I divided my class into two groups--

the below average group and the average and above average group. This was done by checking I.Q.'s (see Table 1) and having consultation with their former math instructor. In the average group, particularly, you usually find lazy individuals. Here was my problem. How much work could I get them to do? Finally I decided that I would expect the best from them and if they did not give me their best, I might have to do other things with them. I had to change one individual from the upper group to the lower group.

I chose two different texts which in turn have material in them for various levels of achievement--Modern Math by Rosskopf, Morton, Hooten, Sitomer, Silver Burdett Co. and Math at Work by Fehr & Schult, D. C. Heath & Co. My average and above average students were given the Modern Math book. The other book also contains modern math topics but is not so hard so far as the approach or the problems given.

III. EVALUATION

Some of the parents of the students using the modern math book wondered when the "frills" were to be stopped and basic fundamentals begun. I tried to get the pupils to see that fundamentals were also being reviewed while these extras were being explored. I tried to show them that they were learning the "why" as well as the "how". Most responded. By checking Table 2, I feel that sufficient gain was made in fundamentals.

I was a little discouraged with the gain made in reasoning ability. Too many individuals were still asking for help on written problems. I hope in another year or two that more independence will be shown on the part of these average students particularly.

Another thing I noted was that my slower students, as well as the rest of the class, handled fractions better at the end of the review period than any other group of seventh graders I have had.

Grading is a serious problem for me. Sometimes very little progress is made within a six-weeks period. Perhaps the student is slow or lazy and does no homework. His first test on the material is not good, so he is given remedial work. Maybe he finishes one unit during the grading period. When you have to grade with A, B, C, D, F, it is very hard to determine the grade that will be fair to him.

Next year, I would like to somehow change the grading system for this class. I would like to be able to figure out just how far each student should be expected to go in the textbook. I am afraid that by setting a definite page in the book I will be defeating my purpose. I was trying to discourage my setting a goal and encourage the students' setting a goal. If I set a goal, I feel that I will be right back where I was in group teaching--taking the pupils so far whether understanding was there or not.

The school gave STEP and SCAT tests at the close of the first semester. Table 4 shows how my seventh grade pupils did on the math section and natural ability section. A tabulation of the students' I.Q.'s are shown in Table 1 so that they may be checked against actual accomplishments.

Other than my own tests I gave only one standardized test, California Arithmetic Tests for Junior High Level. This was given in September and a different form of the same test was given in May. Although I did not feel these tests to be adequate, they did give me one picture of the evaluation. I do not know what the improvements would have been in group teaching but can only theorize.

Notice that the poorest student (Student F) made an improvement of nearly one whole grade placement. The poorest improvement was made by Student D who only improved by .4 of a grade. However, h[illegible] is still slightly higher than average. The better individuals improved 2.4 and 3.4 grade placements.

Following is a resumé of the results of the tests given. The diagnostic profile chart for each student contains shaded areas to the right and left sides

of the chart. Scores in the shaded area to the right suggest that the student can function above the range of grades for which the test was specifically designed. Scores in the shaded area to the left suggest that the student is functioning below this range. Thus, if the majority of the student's scores fall in the shaded area to the right of the profile, another test using the advanced level should be given to yield a more accurate evaluation of his actual achievement. Also a more accurate evaluation could be shown by giving the elementary level test to those students whose scores fall mostly in the shaded portion to the left of the chart.[1]

For the student who is of average ability or less, a vertical line was drawn on their profile chart one grade placement to the left of his actual grade placement. If scores on any tests hit on or to the left of this line, there is a definite weakness that needs to be worked on. For some of the students who have demonstrated average ability and for those with above average ability, the vertical line was drawn one school grade to the left of his mental age. Even when all the test scores are to the right of the line, one or more scores may be low in relation to the test score and the scores of the other sections of the test.

In figuring percentile ranks, I was very careful to see that the correct grade placements were used. Some percentages jumped decidedly.

Student B

September: Arithmetic meaning and symbols, rules, and equations used in reasoning fell to the left of the line that was drawn one grade placement to the left of his mental age grade placement. Division as a fundamental process fell in the shaded left.

May: No scores were on or to the left of the line drawn according to his grade placement. The lowest score was found in symbols, rules, and equations used in reasoning.

1. Tiegs, Ernest W. & Clark, Willis W. in "California Achievement Tests Manual", California Test Bureau, Del Monte Research Park, Monterey, California.

There was a decided jump in both arithmetic reasoning and arithmetic fundamentals during the year. The percentile jump was from 20 percent to 82 percent. His arithmetic grade placement in the fall was 6.2 and in the spring 8.7. The STEP math score showed that he seems to be working to his ability. Perhaps this is an indication that he leaned on others in the class before. Now what he got, he got for himself and retained it.

Student G

September: Arithmetic meanings in reasoning and subtraction fundamentals fell in shaded right. Addition, multiplication, and division as fundamentals all fell to the left of the line drawn one grade placement to the left of the mental age placement.

May: No score was on or to the left of the line drawn according to mental age placement. In fact all scores but one were in the shaded area to the right. In order to tell just where this individual stands, an advanced level test should be given.

The lowest score was in division but it just missed the shaded right area. There was a large improvement in arithmetic fundamentals. The overall percentile jump was from 96 to 99+. This person's arithmetic grade placement in the fall was 8.9 and in the spring 11.3.

Student H

September: Arithmetic meanings in reasoning fell in the shaded right area. All other scores on the test fell to the left of the line drawn one grade placement to the left of the mental age placement with multiplication fundamentals being particularly low.

May: The line drawn one grade placement to the left of the mental age placement is in the shaded area to the right of the chart. This person should be given an advanced level test to find out just what is known. All fundamentals are

to the right of the line which is already in the right shaded area. However, I find this person to be weak in all phases of arithmetic reasoning. They all are found to the left of the line at approximately grade 9 level.

There was a tremendous improvement in arithmetic fundamentals and quite an improvement in arithmetic reasoning. To me this indicates that fundamentals are learned better by not stressing them as such. The percentage jump was from 58 in the fall to 99+ in the spring. The grade placement changed from 7.3 to 10.7. The STEP test also found this student to be in the 99th percentile in math.

Student D

September: All scores fell to the right of the line drawn one grade placement to the left of the mental age placement. There is one (arithmetic meanings in reasoning) that fell in the shaded area to the right. Although multiplication was to the right, it shows a deficiency (below actual grade level).

May: Again all scores are to the right of the line drawn one grade placement to the left of the mental age placement. Arithmetic meanings in reasoning is again in the shaded right area; so is addition as a fundamental process. Subtraction, multiplication, and division scores are a little lower than actual grade level and show that remedial work is needed. There were slight improvements but one big one in addition. The percentile score shows a loss from 82 to 78. The grade placement changed from 8.1 to 8.5. The STEP test found a percentile score in math of 79.

Student I

September: All reasoning scores were slightly to the right of the line drawn one grade placement to the left of mental age placement. This person is a little weak in symbols, rules, and equations. All scores in the fundamentals (addition, subtraction, multiplication, and division) were to the left of the line with division being very poor--in the shaded left area.

May: Only one score, multiplication, remained to the left of the line drawn according to mental age placement. Comparison of the two tests shows that most improvement came in use of the fundamentals. Multiplication did not improve but the others showed a decided jump. Percentile scores improved from 50 to 68 with grade placement increasing from 7.0 to 8.2. The STEP test showed a percentage of 84 in math.

Student A

September: All scores but one (subtraction fundamentals) lie to the left (and in the shaded area) of the line drawn one grade placement to the left of actual grade placement. This means that the test was too hard.

May: Reasoning problems and meanings in reasoning still are on or to the left of the line. Written problems score lies in the shaded area to the left. All fundamentals improved and lie to the right of the line although all are still slightly below actual grade level.

There was a decided improvement in the work of this individual. She shows that much help is needed in order for her to be able to understand and work written problems. Percentage scores show improvement from 7 to 36. Grade placement rose from 5.2 to 7.2.

Student F

September: Every score on the test will be found to the left of the line drawn one grade placement to the left of actual grade placement. Each score is also in the shaded left portion. An easier test should be given to determine just where this individual stands. This person has no idea as to arithmetic meanings.

May: Arithmetic fundamentals, subtraction and multiplication, jumped to the right of the line. All other test scores are to the left of the line and in the shaded portion. Very little improvement was made in the percentile rank--from 5

to 8 percent. Grade placement, however, did improve from 4.9 to 5.8. According to the STEP test, 21 was the percentile score obtained in math.

Student C

September: Weakness is shown in arithmetic meanings as this score is found on the line drawn one grade placement to the left of mental age placement. Symbols, rules and equations score is to the left of the line.

May: All scores remained out of the shaded areas. Meanings and written problems scores are to the left of the line drawn one grade placement to the left of mental age placement. Division score is on the line with other fundamentals to the right. There was a big improvement in most of the fundamentals. The percentile scores on the total arithmetic test increased from 36 in the fall to 60 in the spring. Grade placement increased from 6.6 to 8.0.

Student E

September: Arithmetic meanings, subtraction, and division are found to the right of the line drawn one grade placement to the left of actual grade placement. All other scores are to the left of the line. Written problems, addition, and multiplication are in the shaded area to the left.

May: All scores with the exception of addition fundamentals are found to the right of the line drawn one grade placement to the left of actual grade placement. However, all of the fundamentals remain lower than actual grade placement. In arithmetic reasoning all scores are approximately on actual grade placement. Addition is in the shaded left portion. Much work needs to be done here.

Percentile scores started at 28 percent last fall and ended with 44 percent in the spring. Grade placement rose from 6.3 to 7.5.

On the following page, Table 1 shows the class I.Q.'s, grade placements, percentiles and results of the STEP and SCAT tests.

TABLE 1

(Average Indicated I.Q. of the Henmon Nelson Test of Mental Ability and The California Mental Maturity Test)

Student	Average I.Q.
A	90
B	105
C	107
D	106
E	96
F	82
G	125
H	128
I	107

TABLE 2

Class Summary
California Arithmetic Test Grade Placement

(SEPTEMBER, 1962)

Reasoning	Fundamentals	Total	
9.7	8.0	8.9	(Student G)
8.6	7.5	8.1	(" D)
7.7	6.9	7.3	(" H)
7.6	6.9	7.0	(" I)
6.8	6.3	6.6	(" C)
6.6	6.3	6.3	(" E)
5.4	6.0	6.2	(" B)
4.5	5.9	5.2	(" A)
4.5	5.3	4.9	(" F)

(MAY, 1963)

10.9	12.3	11.3	(" G)
9.0	11.8	10.7	(" H)
9.0	8.8	8.7	(" B)
8.5	8.0	8.5	(" D)
8.5	8.0	8.2	(" I)
8.0	7.9	8.0	(" C)
7.9	7.4	7.5	(" E)
7.0	6.9	7.2	(" A)
4.6	6.9	5.8	(" F)

TABLE 3
CLASS SUMMARY
CALIFORNIA ARITHMETIC TEST
PERCENTILE STANDING

(SEPTEMBER, 1962)

Reasoning	Fundamentals	Total
98	80	96 (Student G)
90	68	82 (" D)
68	48	58 (" H)
60	40	50 (" I)
40	30	36 (" C)
36	25	28 (" E)
16	48	20 (" B)
7	25	7 (" A)
7	10	5 (" F)

(MAY, 1963)

99+	99+	99+ (" G)
88	99+	99+ (" H)
75	80	82 (" B)
88	60	78 (" D)
75	58	68 (" I)
58	60	60 (" C)
60	32	44 (" E)
35	44	36 (" A)
4	34	8 (" F)

TABLE 4
STEP and SCAT
FEBRUARY, 1963

No. of Student	Math	Natural Ability
A	8	35
B	91	76
C	69	50
D	79	66
E	62	54
F	21	8
G	98	99
H	99	97
I	84	73

IV. SUPPLEMENTARY PROCEDURE AND EVALUATION

Since this study is to be a continuing thing, I would like to continue my first year's results with a few observations and changes made during the second year.

I feel that this individualization worked very well with the better students. You can see by the tables that irrespective of the kind of test given that the two outstanding students reached close to the 99th percentile.

I did try changing my grading system in 1963-64. Each student chose his own goal. Although he did not always reach it, he had a goal for which to try, making him respond better. I did not penalize him for material not covered, unless it was apparent to me he was not trying. I requested twenty minutes work each day outside of math class for homework. Each day each student filled out a slip telling me how much homework was done and what work was accomplished. More material was covered and I believe it was mastered just about as well.

So long as students were keeping up, they could work at the "lab" table once a week. On this table was a variety of projects from which the individual could choose. Below is a sample of the copy given each student. I had two outstanding notebooks at the end of the year.

POSSIBLE PROJECTS

Project Day is Voluntary

1. Scale drawings. You may use an encyclopedia or other books to know the proportioned size of drawings such as aircraft, house plans, one piece of furniture, a building, a yard plan, etc. You are to choose a different scale and make an attractive drawing of your own. At the bottom of your picture, please give the name of the author, the name of the book, the name of the publishing company, year of publication of the book, and the page number so that I may check to be sure you used a different scale from that used in the book. (Don't forget that in scale drawings the scale you use must be by your picture.)

2. Every month we need a different bulletin board display. Perhaps you would like to collect jokes about math or those related to science. Perhaps you can find attractive pictures to use, etc. If you choose to do this, please plan to make one complete bulletin board display, attractively arranged. (If construction paper is needed, we have some you may use.)

3. Choose some model you have been dreaming about building. Make a small working model of it out of toothpicks, light wood, cardboard, or the like.

4. There are many other textbooks that have chapters or sections in them that are new to you. You may choose to study these parts and write in your notebook an outline of the topic you choose.

5. The journal "Science and Math Weekly" contains many interesting articles on science and math. Read any one or all of the articles, summarizing them in your notebook.

6. There is a list of booklets available for your project grade. You may choose to work in any of the books on your list.

7. If you have ideas for a project that is different from the above, please see me to get an o.k. to go ahead with it.

For reasons of comparison, I gave different forms of the California Arithmetic Test for Junior High Level again in the fall of 1963 and the spring of 1964. The results are shown in Tables 5 and 8. Although the gains do not seem to be as large as during the previous year, we must remember that for some individuals 8th grade math is not easy to comprehend. I noticed that grade placements did not drop very much from the spring of 1963 to the fall of 1963. This is an indication to me that the work covered the previous year must have been learned and not just gone over.

As in the first year, many scores from the California Test fell in the shaded area to the right of the chart. So in April, 1964, I gave the math test of the Cooperative Test Division, Educational Testing Service. The test was divided into four parts. I have given the class percentile ratings on each part in Table 7. The two outstanding students are still pretty well at the top.

TABLE 5
CALIFORNIA ARITHMETIC TEST
GRADE PLACEMENT, SEPTEMBER, 1963

Reasoning	Fundamentals	Total	
11.2	11.1	11.2	(Student G)
10.5	9.3	9.9	(" H)
8.9	9.3	9.1	(" D)
8.3	9.7	8.5	(" I)
8.3	8.4	8.3	(" B)
7.6	7.5	7.5	(" C)
7.6	7.5	7.5	(" E)
6.2	7.3	6.8	(" A)
4.5	6.4	5.5	(" F)

PERCENTILE STANDING, SEPTEMBER, 1963

99+	95	99+	(Student G)
96	75	92	(" H)
76	74	78	(" D)
58	64	62	(" I)
58	58	58	(" B)
38	35	32	(" C)
38	35	32	(" E)
12	30	10	(" A)
1-	14	3	(" F)

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TABLE 7

COOPERATIVE MATHEMATIC TESTS
GRADES 7, 8, and 9
EDUCATIONAL TESTING SERVICE

PERCENTILE RANK

No. of Student	Skills	Facts, Terms, Concepts	Applications	Appreciation
G	99+	99	93	99+
H	99+	96	78	99+
D	74½	70	63	55
I	74½	63	59	23
B	25	63	80	79
C	35	63	24	55
E	25	31	14½	44
A	21	34½	19	36
F	21	7	0	0

V. CONCLUSIONS

This project has helped me greatly as a teacher. I feel that I am much more wide awake, trying always to find something that will help one student at a time build a bridge across his chasm. Minimum paper grading has enabled me to use my time preparing in advance the materials each student will need.

In closing let me say, "It is all for the good of the student that realistic but challenging standards of achievement in mathematics be established at the earliest possible moment. Success in mathematical subjects does not come without challenge and the earlier the challenge occurs, the better will be those who are able to meet the challenge."[1]

1. From the College Point of View in "Colorado Mathematics Teacher", 1962